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Sea-Jeeps on Practice Run—Ford Photo from OWI.

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The Science Teacher

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Frequency Modulation and Its Place in Post War Broadcasting

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THE ACCELERATION in the development of electronic devices for use in the war effort has exceeded that in any other field. Out of the war will come many new electronic applications which two years ago were but in the laboratory stage of their development. Frequency Modulation, while highly developed before Pearl Harbor, is benefiting greatly by the continued research and wide application which this means of communication has attained. The question now facing radio broadcasters and educators alike is "What place will Frequency Modulation (abbreviated FM) have in the post war radio broadcast picture?"

To answer this question intelligently, it will be necessary to delve into the background and underlying principles of FM. Radio waves in themselves convey no intelligence from the point of transmission to the point of reception other than the fact that the waves are present. They are similar to the light waves from a blinker signal light that is burning continuously. If intelligence is to be transmitted by means of the blinker light, it is necessary to alter the beam in accordance with some prearranged plan. Therefore a system of flashing the light in accordance with the international Morse code has been developed—a short flash for the dots and a long flash for the dashes. By so doing, the light beam is being *modulated* with the desired intelligence. Similarly, it is possible to modulate a radio wave by starting and stopping it in accordance with the code symbols. This wave is *Amplitude Modulated*. The amplitude is varied from zero in the spaces between dots and dashes to full value during the dots and dashes.

ANOTHER method of light signaling is used on the railroad systems. Here the light burns continuously, but the intelligence is transmitted by changing the color of the light with appropriate filters. This is a system of *Frequency Modulation* of the light. The frequency of the emitted light is varied in accordance with the intelligence to be transmitted. In a like manner, code signaling can be applied to radio waves by Frequency Modulation and was in general use up until the end of the first World War. A tuning condenser connected in the circuit thru a telegraph key caused the transmitted frequency to shift whenever the key was depressed. The receiver was tuned to the lower frequency signal to receive the message.

Our present system of radio broadcasting has been built around the use of *Amplitude Modulation*. The voice and the music to be transmitted are used to control the amplitude of the radio wave. Figure 1 shows such an AM wave. If a tone with a pitch of middle "C" were being transmitted, the amplitude of the radio wave would vary 256 times a second. The louder the sound the greater would be the variation in amplitude until the minimum points touched. It is not possible to modulate beyond this point of 100% modulation without introducing objectionable distortion.

THE SYSTEM of Frequency Modulation developed by Major Armstrong bids fair to

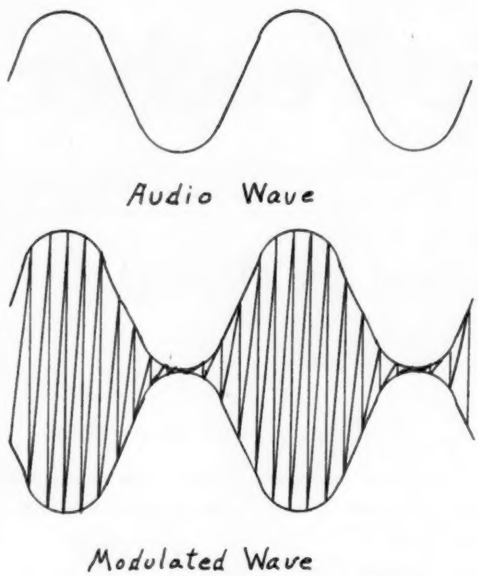


Fig. 1. In AM the amplitude is varied.

alter the structure of the broadcast picture built around twenty years of AM operation. In this system the frequency of the emitted wave is controlled by the voice and the music to be transmitted. Figure 2 is an attempt to depict the FM wave. Here the middle "C" tone would cause the frequency to vary above and below normal 256 times a second. The louder the signal becomes, the farther will the frequency swing above and below the normal or carrier frequency. There is no limitation on how great the frequency swing can be except for the possibility of interferring in the next channel.

Figure 3 shows a block diagram of a complete FM system and a complete AM system for the purposes of comparison. Note the development and the change affected in the original signal in each of the systems.

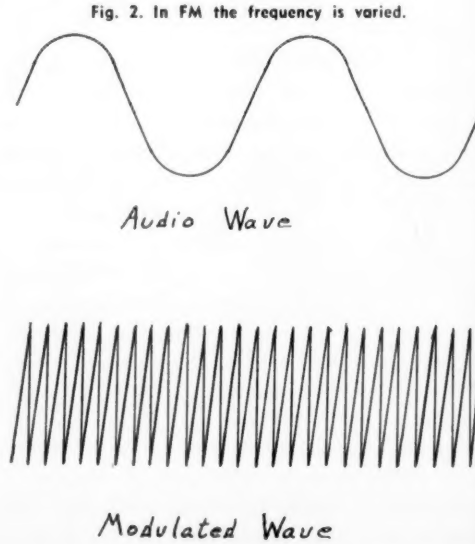
Any system which its proponents predict will replace the existing ones must offer certain advantages. By the same token the fact that there is some discussion as to the relative merits of the old and the new implies that there are some disadvantages. FM offers the following advantages:

1. Lower noise level.
2. Greater fidelity of transmission.
3. Less common channel interference.
4. A clean start.

The outstanding advantage of the FM system of transmission is in the reduction of the noise level. This reduction makes possible greater coverage at a given frequency and permits the utilization of higher fidelity. There are several factors which contribute to the reduction of the noise level. All noise voltages have components varying in both frequency and amplitude, but the frequency variation of the noise components is much less than the amplitude variations. By making the desired frequency variation due to frequency variation becomes insignificant. For this reason a frequency swing of 75 kilocycles on either side of the center frequency has been adopted as standard, so that each station requires a channel 150 kilocycles wide for transmission. To protect the adjacent channels, a 25 kilocycle guard band has been established. Altogether, each FM station requires a channel 200 kilocycles wide, a channel that will accommodate 20 standard AM stations.

NOISE reduction is also the result of a condition peculiar to the FM system. The intensity of random noise interference in FM or pitch of the noise. Thus, at low frequencies

Fig. 2. In FM the frequency is varied.



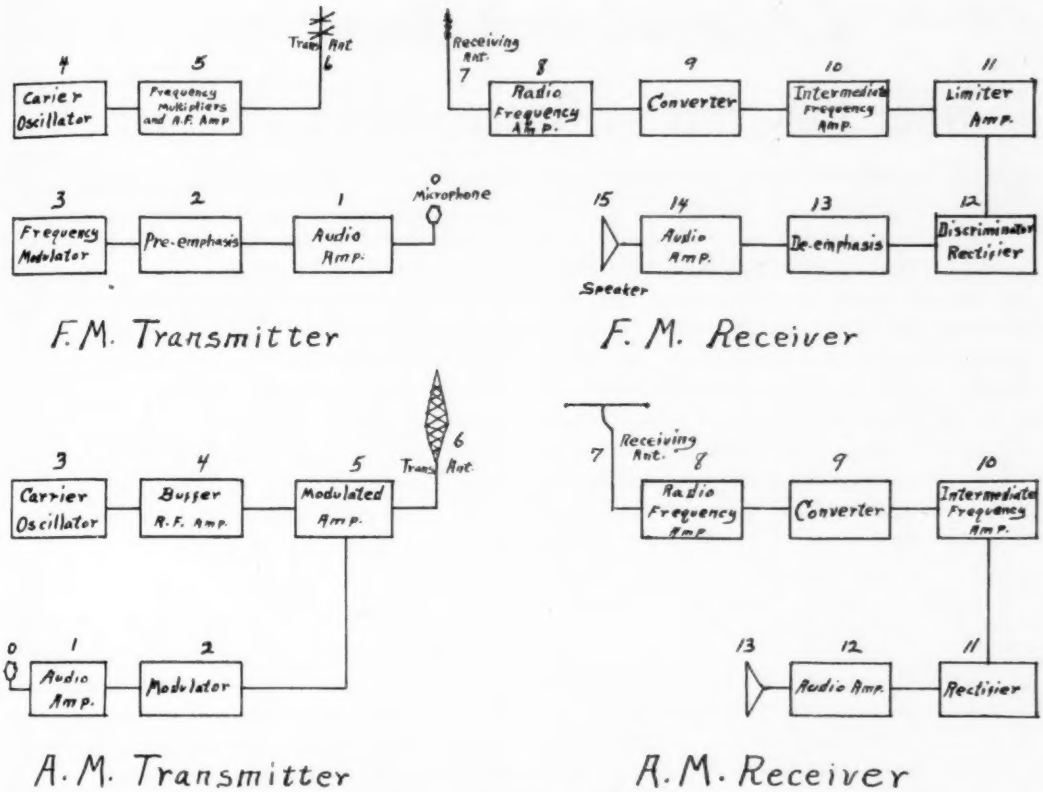


Fig. 3. Block diagram showing comparison of a complete FM and AM system.

the noise is very low while at the higher audible frequencies it increases somewhat. On the other hand, the intensity of musical tones from the average production is almost the exact opposite of this characteristic. The greatest intensity occurs in the middle frequency range in the vicinity of 400 cycles and drops off rapidly as the frequency is increased. It is therefore possible to pre-emphasize the high frequency components of the voice and music at the transmitter, and de-emphasize them at the receiver without destroying the original balance of the tones. The pre-emphasis circuit amplifies the high frequencies much more than the medium and low frequencies. The de-emphasis circuit reduces the level of the high frequencies with respect to the center frequencies and at the same time, reduces the level noise.

The third factor contributing to the overall reduction of the noise level in the FM system is an inherent propagation characteristic of the high frequency used as a carrier for FM signals. In order to find space for a number of stations each having a band width of 200 kilocycles, it is necessary to go to the high frequency bands in the vicinity of 45,000 kilocycles. Here the interference effects of static and man-made noise sources is greatly reduced, whether the system be AM or FM.

By combining all these factors, the FM system shows a reduction of about 25 decibels in noise level as compared to the AM system. If a noise which is objectionable in the reception of radio programs is reduced 25 decibels, it is generally reduced below the threshold of hearing and appears to be eliminated. This accounts for the erroneous conclusion that FM eliminates noise. It only reduces its effects.

THE SECOND real advantage of the FM system over the AM system of transmission, greater fidelity of transmission, is largely the

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Editorial and News

What Difference in Science Education Ahead?

WHAT DIFFERENCE may we expect in science education as a result of the great changes of the present era? Certainly wartime needs have forced changes in the curriculum and in many courses for the present. But let us consider the question in more detail.

In structural materials there are great changes which may prove revolutionary in terms of living conditions. Plastics almost without end are now produced in quantity and with unlimited possibilities in application. Rubber is designed with special properties to meet each special use. Light metals are made of great strength and durability. Will such new products, vitally affecting life, make a difference in our science courses?

IN EQUIPMENT and in the things we use there are great changes that will affect our living. Radio, utilizing frequency modulation, is on the way to eliminating static completely. Radar, based on electromagnetic radiation, will be a great factor in safety of air transportation. And the airplane may soon well become a family convenience instead of a novelty. Will these and other features that have undergone revolutionary change, such as insulation, heating, and lighting, make any difference in science education?

In the methods of production there have been vast improvements. Rigid control has become a key word. In steel making, for example, not only is the composition carefully checked, but the physical factors in rolling and shaping that make for strength and quality are now under control. In oil refining the modern catalytic cracking plant can at the will of man produce from oil not only the products of quality wanted but can vary the amounts of each obtained according to human needs.

IN THE biological sciences as well as in the physical, controls are vitally important. If it is bacteria in disease, of which the average person usually thinks, the control today is highlighted by the dependable performance of the sulfa drugs or penicilin. But we continue to search for something that will give even better control. With the corn plant, undreamed of control has come through the hybrid. This interesting plant may be set to resist the insects of the South or the corn borer of the East or North, or it may be set to ripen with one-hundred bushel yields on Canadian farms where corn was once thought an impossibility. With control a major factor in all sciences and in our environment what attention shall we give it in science teaching?

Then there are changes in method in science teaching as found in army schools where a maximum of facts, principles and applications must be learned in a minimum of time. Are there methods here that will replace or supplement those in common use in the schools? At present is much school time being wasted that could profitably be used in other ways? What do you think about it?

MOST OF us would agree that the fundamental basic principles of science are unchanged and that they are just as fundamental to understanding the new and revolutionary products and appliances of the present and future as of the past. But will the emphasis on what is taught be different? What will be the vital features of the science course in each area and on each level? Will methods be changed? We invite your reaction. Write us your opinion.

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In both New York City and Chicago the National Science Teachers Association collaborated with other science teachers' associations of the area to hold meetings during the Thanksgiving holiday period. In Chicago the program centered about *Consumer Education*. At New York one feature was a discussion of *Science and the National Welfare*.

Report of Resolutions Committee*

1. World War II found science teachers of the nation so poorly organized that concerted action in exploring desirable curriculum modifications and critical evaluation of the many diverse and often conflicting reports of wartime needs was impossible.

The crisis merely threw light on what has been a longtime weakness in the development of sound science education in this country even in peacetime. Channels for the exploration and dissemination of newer and significant curriculum and instruction practices were insufficient. No large scale clearing house of ideas, technics, and materials was available. The good ideas of the teacher of Middletown were generally destined to die with the teacher, or to reach the teacher of Bordertown by a dishearteningly slow diffusion process.

The committee on resolutions of 1943 undertook to recommend that the Council assume leadership in affiliating with various other national and regional science teachers associations for the exploration of wartime and postwar problems of science teaching.

Steps were taken by the Council for such affiliation in the interests of better science teaching. The membership of the American Council of Science Teachers and the American Science Teachers Association has ratified and supported the proposed merger of these two associations with virtual unanimity.

Your present committee on resolutions recognizes the great importance of the merger which has been effectd. It is acutely aware, however, of the necessity to support the furtherance of such affiliation with other organizations and to recommend certain basic steps through which such cohesive organization of the science teachers of America may result in the largest advantages to science education.

The resolutions which we respectfully submit to the Council are, therefore, those which your committee believe to be basic next steps.

Be it therefore resolved:

1. That the American Council of Science Teachers and the American Science Teachers Association, merged into the newly formed National Science Teachers Association, shall continue their efforts toward more cohesive organization of the science teachers of the United States in the interests of science education as expressed in Article II of the constitution of the National Science Teachers Association.

2. That the values of such organized effort of, by, and for the science teachers of the nation be increasingly demonstrated through establishment of the following standing committees charged with the responsibility of studying the experience and best thinking of teachers throughout the country and annually reporting to the National Science Teachers Association of their findings.

The committees which are here specifically proposed are:

a. Committee on sequence and articulation of elementary, secondary, and college science instruction. (This committee would be charged with the responsibility of studying the problems of sequence in the science curriculum).

b. Committee on the relationships of science instruction to instruction in non-science fields. (This committee would be charged with the responsibility of exploring the place of science in the total general education curriculum and of bringing into relief the peculiar contributions that science can make to young people and society).

c. Committee on aims and general procedures of science instruction. (This committee would be specifically charged with the responsibility of discovering, evaluating, and synthesizing curriculum materials in furthering functional science education to meet the personal-social needs of young people and society. Furthermore, this committee would be charged with the responsibility of exploring trends in educational philosophy, conflicting and varying goals of science education, special demands similar to those recently avowed by the military forces, and the imminent but continuing demands of a postwar world. Sub-committees in such areas as international education, health, conservation, racism, and production may be established to consider intensively certain aspects of functional science instruction).

d. Committee on specific technics and source materials in science instruction. (This committee would be charged with the responsibility of drawing together interesting new technics from the teachers of the country and with reviewing sources of instructional materials available from governmental, industrial, and service organizations. This committee would also act as an advisory committee to such organizations in the development of more adequate educational materials).

e. Committee on publications and on audio-visual aids. (These two committees would be charged with the responsibility of reviewing textbooks, teachers' reference books, professional educational books pertinent to the science teachers' work, and audio-visual aids pertinent to science instruction. These committees would not only review productions in these fields but would also promote activities where they seem to be needed, and act as consulting boards to authors, publishers, or producers of audio-visual aids when so requested).

f. Committee on teacher education. (This committee would be charged with the responsibility of studying the status and trends of pre-service and in-service teacher training and in recommending modifications of present procedure in the interests of sounder science instruction).

g. Committee on curriculum and instruction technics as employed in the armed forces. (This committee would be charged with the responsibility of studying the teaching and organization of curriculum material of the military forces and in recommending possible adoptions or modifications of such teaching and organization for civilian science programs).

It is further resolved:

3. That the chairman of each of the standing committees above represent their committees in comprising, together with the board of directors of

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*Presented by the Resolutions Committee at the Pittsburgh Meeting of the American Council of Science Teachers, July 5, 1944. Committee members were R. Will Burnett, Chairman, W. Bayard Buckham, Charles U. Cross, J. W. Galbreath, Don Gordon, Norman R. D. Jones, and Franklin Mathewson.

Military Hygiene

WILBUR F. DOUGLAS

Polytechnic High School — Long Beach, California

This article is taken from the material presented by Mr. Wilbur F. Douglas to his class in Military Hygiene. *The part dealing with alcoholism and sex hygiene will be presented in the February issue.*—EDITOR.

SOME months ago a letter was turned over to me, written by the captain of a merchantman on the Atlantic to his son, then a senior in this high schol. Here is a quotation from it:

"That class you mentioned, being conducted in school — is a most timely one. From what I hear of conditions out here, things are pretty bad; and I suppose it is the same out there. Learn all you can at those classes—NOT the hard way—by experience."

The hazards to be mentioned are unavoidable; how will you meet them?

CONTRARY to what you may fear, in all probability you will return from this war. All the the wars in which our country has participated have produced only about a quarter million of battle fatalities. When you compare this figure with the nearly one hundred thousand accidental deaths *each year*, you see your chances of surviving the war are pretty good. Your training will increase your chances if you apply yourself. Some branches of the service are more hazardous; and, more unfortunately, the casualties are from among our finest boys because of the high enlistment standards.

The most important question is: *What kind of a man will you be when you come back?* Much of the answer to this question rests with you.

Disease as a Factor in War

THE word 'hygiene' implies that this course should be concerned with those habits and actions that the *individual* service man can use to protect his own health. On the other hand, sanitation refers to *group* activities such as community disposal of wastes, the protection of food and water from contamination, and group immunization to communicable disease. But the individual service man is also a part of a closely-knit group, so that no sharp line of distinction can be drawn between hygiene and sanitation in military life. It is our purpose to point out facts that will help you to understand, as well as carry out, the sanitary measures imposed by service regulations. There are also many ways in which your own intelligent initiative can well serve your physical and mental welfare.

Epidemic diseases and warfare have gone hand in hand throughout history. In fact, disease has changed more military decisions than the generals have. Armies have always been the means of spreading infectious diseases.

WHAT is some of the historical evidence that the foregoing statements are true? In his interesting book *Rats, Lice, and History*, Hans Zinsser, the late great Harvard bacteriologist relates many such instances in the history of warfare. Here are just a few of them.

1. The Greek historian Herodotus records how a Persian army under Xerxes, numbering 800,000 men, invaded ancient Greece without successful opposition until epidemic disease (probably plague and dysentery) reduced it to less than a half million men and sent it back to Asia, defeated.
2. In the Punic wars between Rome and Carthage, sieges of Syracuse on the Island of Sicily were raised in 414 and 396 B. C. by outbreaks of bubonic plague in the besieging Carthaginian army.
3. In 425 A. D. the Huns gave up an unopposed advance on Constantinople because of the spread of an unknown disease among their troops.
4. The Crusades offer a spectacle of nearly two centuries of repeated military disasters in which armies of hundreds of thousands would be reduced in a few months to pitiful remnants by the twin scourges of undernutrition (scurvy) and epidemic disease.
5. In 1439 the German Emperor, Albrecht, reached Bagdad on October 1. Within two weeks his army was defeated by dysentery, and the Emperor was dead.
6. Syphilis contributed largely to the defeat of Charles VIII of France in his campaign against Naples early in the sixteenth century.
7. In 1566 Maxmilian II of Germany was preparing an army of 80,000 men to oppose

the Turks in Hungary. Typhus broke out and assumed such proportions that the campaign was abandoned. This episode probably resulted in the permanent establishment of typhus, the most feared of modern military diseases, in the Balkans.

8. In 1632, during the Thirty Years' War, the Swede Gustavus Adolphus was facing Wallenstein before Nuremberg. When 18,000 soldiers died of scurvy and typhus, the remnants of both armies retired without joining battle.

9. In 1708 the Swedes, after achieving a military victory in Russia, were utterly defeated by bubonic plague.

10. In November, 1741, Prague was surrendered to the French because 30,000 of the defending Austrians died from typhus.

11. It is a familiar story how the greatest general of them all, Napoleon, lost an army of nearly half a million men in Russia. Typhus and dysentery loom large as factors in this catastrophe.

12. Typhus fever can reasonably be said to have played a decisive role in World War I. Austrian and German hesitancy in throwing sufficient forces in to Serbia in 1914-15 was dictated by fear of bringing that disease, then raging in that unhappy country, back with the wounded. Following the Russian collapse in 1917, typhus killed three millions of people in European Russia and Poland.

IN ESTIMATING the health hazards of the present war and attempting to meet them, it is helpful to ask *why* war has always been accompanied or followed by such a marked increase in epidemic disease.

The first answer is that military measures always incur the congestion of large numbers of people into small areas. Cargo vessels are transformed into transports; trains are overloaded; amps and barracks bring together in close proximity thousands of men, some of whom almost invariably harbor dangerous infections to which their comrades are susceptible.

War, particularly this one, transports millions of both military and civilian personnel to new and distant places where the indigenous diseases offer serious health hazards because the newcomers have no natural or previously acquired immunities.

THE NORMAL controls over the spread of disease, such as the isolation of sick individuals and the practice of individual and community cleanliness, are difficult to maintain under the conditions of active service. On the other hand, the desolation, undernutrition, filth, social ruin, and mental strain which follow active military operations are a fertile seed bed for the germs of disease.

How do the Health Hazards that Confront Our Armed Forces in this War Differ from Those Met in Past Conflicts?

Vaccination and other methods of immunization have controlled some of the military scourges of the past. After you are inducted into one of the armed services, you will be immunized to typhoid fever, smallpox, tetanus, and perhaps other serious diseases. But there is no generally used method of immunizing you against two great World War II enemies of our forces in the field—malaria and dysentery.

The variety of health problems confronting our men and the remarkable medical solutions that have been achieved are well described in a current magazine. You will profit by reading: "The Healing Arts in Global War", in the *National Geographic* magazine for November, 1943.

THE DISEASES that are of the greatest military importance can be conveniently classified according to their methods of transmission. Although the following list is not complete, it probably includes most of the scourges that constitute actual or potential hazards to our forces scattered throughout the world.

Respiratory: (through mouth and nose spray)
- Influenza
- Pneumonia
- Meningitis
- Smallpox

Insect carriers:
- Malarial fever
- Yellow fever
- Typhus fever
- Bubonic plague
- Dengue fever
- Sleeping sickness

Intestinal: (contamination of food or water)
- Bacillary dysentery
- Amoebiasis
- Asiatic cholera
- Typhoid fever

Contact: (direct or indirect)
- Venereal diseases
- Smallpox
- Tetanus (wounds only)
- Gas gangrene (wounds only)

THERE is little the individual can do under service conditions to protect himself against respiratory infections, except to have all possible respect for the principle of isolation. As noted previously, this is a difficult problem. Your instructor once stood guard, six hours daily, in the aft hold of a trans-Atlantic transport watching over about a dozen soldiers who were dying of pneumonia. Their segregation under such limited and dismal surroundings seemed ruthless but was an effective means of keeping this deadly infection from hundreds of their comrades.

Recent medical developments, such as the sulfa drugs, convalescent serums, and better nursing care promise to lower the mortality rate from the respiratory infections. Although meningitis and smallpox are not disease of the breathing organs, the latter are the avenue through which these serious diseases frequently enter the body. Smallpox was the first disease to be effectively controlled by vaccination.

The chief menaces to the health of our armies and amphibious forces in World War II seem to be the insect-carried diseases and and intestinal infections. These hazards will increase as the areas devastated by our barbarian enemies are more deeply penetrated on the roads to Berlin and Tokyo.

MOSQUITOES, lice, fleas, and flies are the sole agents for the transfer from human being to human being of some of the worst plagues in military history. The entomology of these insect vectors has assumed a vast importance to our armed forces, because it is the key to successful control measures. The Japanese have actually attempted to start epidemics of bubonic plague in China. In view of this fact, a leading entomologist of a large Mid-Western university recently made the serious suggestion that the quickest way to bring our Oriental enemies to time would be to sow the infected vectors of yellow fever, plague, and typhus over the Japanese-held islands and homeland. The mere fact that such a suggestion could be made by a responsible scholar is eloquent testimony to the brutalizing effect of war on the psychology of a people of good will.

Malarial fever is the most potent disease enemy that threatens our military effectiveness at present. Ten days before the surrender of Bataan, an estimated 80 percent of the American troops had malaria. When the First Division of Marines were finally taken off Guadalcanal, 70 percent of them were suffering from this protozoan blood infection. Malaria is prevalent in Burma, India, New Guinea, Trinidad, and North Africa, in all of which places we now have troops. The problem of malaria is accentuated by the twin facts that there is no prophylactic vaccine and that the Japanese have a near-monopoly of the world's supply of quinine.

There are three forms of malaria, the malignant malaria of the tropics being the most devastating in its effects. All malaria is carried by some species of mosquito of the genus Anopheles. Since the protozoan germ must live part of its life cycle in the body of the mosquito, before being injected into the blood of the human host with the insect's saliva, the most logical point of attack against the disease is by the destruction of the insect vectors. This destruction is difficult in jungle country because the mosquitoes often breed in the axial pockets between the leaf stalks and the stems of tropical plants. But our forces are being furnished chemical sprays, skin repellants, and even "insect bombs" with which to kill the insects in a tent or squad room.

ONCE the malarial parasites become numerous enough in the blood stream to cause the characteristic rhythm of chills and fever, the only known cure is through adequate treatment with the natural drug, quinine, or the synthetic atabrine. Treatment is tedious and unpleasant, and the usual history is persistent re-infection so long as the victim is accessible to Anopheles. Keeping the *entire* surface of the body covered with clothing in the early morning and evening when these mosquitoes are abroad will prevent most malarial infection.

In modern times typhus fever, not to be confused with typhoid fever, has been the most devastating of all military diseases. It is a louse-born disease that is again raging in eastern Europe and may yet have an important effect on the outcome of the war. If and when our expeditionary forces are again required to campaign in Europe, this disease may become a grave menace to the health of our troops. The best protection available to the individual soldier is to keep as free as possible from vermin. This is a difficult task under some conditions, as we can testify after once sleeping for three weeks in bunks previously occupied by Algerian troops. However, body lice cannot stand soap and water. In addition, all our men who are destined for a

theatre of operations where typhus exists are given a vaccine developed on the embryonic membranes of incubating chicken eggs. It is apparently excellent protection, for the records of the first year of our campaigning in North Africa, India, Burma, and China show a remarkably low incidence of typhus and no fatalities. And this true for troops that often must associate with civilian population that are "100% lousy."

Body lice, familiarly known by Americans of the last war as "seam squirrels", "pants rabbits" or "crotch crickets", are blood-sucking insects that harbor the typhus germs in their own alimentary canals and transfer them readily to new hosts in their feeding. Typhus is a painful, protracted illness with a mortality rate of from 15% to 70%.

Bubonic plague, the Black Death of the Middle Ages, has probably taken more human lives than any other single disease over the span of history. But its modern role is a minor one since its method of transmission is well understod and there is now a vaccine available to our troops. However, the permanent existence of plague in the Near East and the India-Burma-China theatre makes it a real hazard in the months to come. Rat fleas carry this essentially rodent disease to human hosts. In sucking blood, a minute puncture wound is produced; and insect excrement, alive with plague germs, is deposited close by. The resulting itching causes the host to scratch the infectious material directly into the blood, a case of literally "rubbing it in." The most fatal form of plague, the pneumonic type, is the only one that can be transferred directly from one human being to another without the necessity of the flea vector. A small outbreak of pneumonic plague in Los Angeles in 1924 produced thirty-two cases, of whom thirty died.

You who have always lived in communities with a safe water and milk supply have little conception of the effect of dysentery and other intestinal infections on armed forces. Public sanitation and personal hygiene are almost unknown conditions in many parts of the world where our forces are now operating. Uninstructed human beings have a remarkable tolerance for filth.

IT IS questionable if there are any safe water sources in some of these countries, unless water is first boiled and chlorinated. The clearest of village fountains may be a treacherous source of intestinal infection and entirely 'pas potable', as the French would say. You had better dehydrate for days at a time than disobey orders relative to drinking water and food.

It is one thing to know these facts in a theoretical way but quite another matter to put the information to practical use. Some of the Guadalcanal marines knew better than to drink unchlorinated jungle water but in their thirst did so anyway, with the result that they became casualties from severe intestinal infection. Your instructor once saw an infantry regiment with almost fifty percent of its personnel suffering from the acute diarrhea of bacillary dysentery.

OUR medical corps can be justly proud of the victory that has been won over two dreaded diseases of the past, Asiatic cholera and typhoid fever. Effective vaccines given to all military personnel are responsible for this achievement. Not a single case of cholera among American service men was reported in the India-Burma-China theatre for the year ending July, 1943.

It must be evident from the foregoing discussion that much of the improved record of health in our forces in this war is due to the program of immunization developed by the medical department of the Army and Navy. You have reason to be profoundly thankful for this protection. But this help should only supplement your own intelligent attention to personal hygiene and a cooperative attitude toward camp sanitation. For example, when you are first put on latrine detail, do not consider it as an unjust and degrading assignment but as an opportunity to increase your own and your comrades' chances of returning home with bodies unscarred by disease.

IMMUNITY, or resistance to disease, is not an absolute term, for there are all degrees of it from almost total susceptibility to nearly complete resistance. There is no such thing as absolute immunity except to diseases that never occur in the species. Human beings never have swine cholera, just as horses seldom, if ever, suffer from tuberculosis. On the other hand, *humans* are the only animals that ever naturally have syphilis, gonorrhea, Asiatic cholera, typhoid fever, measles, mumps or infantile paralysis. Sometimes apes and monkeys are artificially inoculated with some of these infections for experimental purposes.

Immunity is also a specific term, for re-

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Reports on the Education of Science Teachers

PAUL ROOD

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THIS is a summary of two national reports on education of science teachers. Some parts of them may rub us the wrong way, some may find us in complete agreement; but if just one improvement in the science teaching of each reader of the reports could occur, the labor of those who are responsible for their publication would be justified.

Several programs for the improvement of the education of science teachers have been underway during the last five years. Among them is the program of the Commission on Teacher Education of the American Council on Education. Cooperating in this are twenty institutions of higher education and fourteen public school systems. This involves the education not only of science teachers but of teachers in general. Another study has been carried on by The National Committee on Sicence Teaching, sponsored by the American Council of Science Teachers of the National Education Association, in cooperation with several national scientific organizations. A third study is being made by The Cooperative Committee on Science Teaching, a group created by five nation-wide science societies to "attempt the solution of important teaching problems that have defied each of them individually."

The following is a brief outline of the accomplishments of the latter two of the three groups mentioned above.

THE NATIONAL Committee on Science Teaching has so far issued three reports, the leading one of which is published under the title "The Education of the Science Teacher." Its purpose is stated as follows: "This report is part of a continuous atempt by educators to maintain a program that is responsive to changes taking place in education." In carrying out this aim, it does two things:

1. It defines the function of teachers with special competence in science, first as persons, second as teachers of science.

2. It recommends materials and procedures that will help prospective teachers to fulfill these functions.

As a person, the science teacher—

a. Should take an active part in the community.

b. Should appreciate the evolutionary nature of American democracy and not accept without question a mode of living just because it exists today.

c. Should learn the scientific method by practicing it. He should examine what people actually do when engaged in scientific research. He must learn to find problems in situations and to find ways of solving them. He does not have to be a researcher in pure science in a laboratory to do this. He may do it in daily life including his daily class lectures. This point which their Committee makes is well brought out in an article by Professor G. W. Stewart in the last issue of the American Journal of Physics. He says that his professor of physics in undergraduate days never engaged in a piece of research in his entire career, but he encouraged his own creativeness in designing and constructing new forms of appartus. And his students observed that there was something living in his subject. This impressed them far more than any exhortation could have done.

The science teacher should appreciate that while the results of scientific attainments are an integral part of the life of all, yet the great weight and power of scientific thinking has not been brought to bear on the problems of society. In reading this, I could not help thinking of the statement made by Professor A. J. Carlson of the University of Chicago in a Sigma Xi address at Philadelphia in December, 1940. He said, "I contend . . . that the great mass of people of our day . . . are . . . as untouched by the spirit of science and as innocent of the understanding of science as was the 'Peging Man' of a million years ago."

d. Further the science teacher should have interests outside his school — in hobbies, in recreational activities and in the arts.

e. Should understand both himself and his students and develop a consistent working philosophy of life which will enable him to give sound guidance and counsel to students.

AMONG the functions concerned particularly with science teaching are included the following:

a. Since about 70-75 per cent of our young people of secondary school age do not attend such schools, while only 15 per cent continue on to college, the teacher should emphasize education that is immediately useful rather than education which is primarily to prepare for college.

b. He should present the best scientific evidence on problems having to do with the good of the community as a whole, such as—

- Sex education.
- Racial prejudice.
- Conflicts about the universe and man's place in it.
- Moral codes and ethical principles.
- Man's place in evolution.

c. He should know the difficulties to which the various age groups are liable. He should be patient with slowness in learning and know that intellect is but one trait and not always the trait most essential to a successful life.

d. He should have adequate preparation in subject matter. This preparation should be characterized by an emphasis on breadth of training with whatever reduction in depth that becomes necessary, rather than the reverse. For this preparation the Committee recommended integrated training areas such as——

- Maintenance of public health.
- Human life span.
- Transportation and utilization of energy.
- Control of organisms.
- Chemical changes, solutions, atomic structure.

With such preparation it is thought that teachers may be able better to take their turn at teaching core courses such as given in Denver and other places.

AS TO materials and procedures that will help prospective teachers to fulfill these functions, the Committee has, in summary, the following to say:

The well-trained science teacher should know how to find and how to use the various material aids. Movies and other visual aids are valuable if they are studied by the class and built into the class work. Numerous free teaching aids are available from government bureaus and from various commercial organizations. Many excellent tests of different kinds are available for use. The teacher should be familiar with the tools of science and should know how to manipulate them smoothly. A teacher who is clumsy with apparatus or unable to make it function spoils most of the effectiveness a laboratory demonstration might have had.

During the college training of the science teacher, there should be provision for the observation of good teaching and for a gradual induction into taking charge of a class, always under competent guidance.

COLLEGE training for the science teacher should consist at least of a four year course, with the first two years for general education and some professional courses in the third and fourth years. It is recognized that four years' training is inadequate to carry out the implications in the Committee's report, and a fifth year of training is highly recommended.

It is emphasized that the background and equipment of a teacher cannot be static but that there must be a program of continuous education during service in the field.

The third agency mentioned at the beginning of this discussion was The Cooperative Committee on Science Teaching. In its preliminary publication "The Preparation of High School Science Teachers" it is made clear that the study is to be limited to the small high school.

The chief difficulty with the training of the teacher going into a small high school is that he trained too narrowly. He will usually have to teach three subjects and some times four

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Combining Thoroughness With Conservation of Time in Teaching Biology and General Science

A. E. HOLCH

University of Denver — Denver, Colorado

ONE OF the greatest difficulties of the educator is the fact that it is impossible to look into the future and to find out just what the needs of society will be in a few years. If it were possible to look ahead and to ascertain what the world will be like a few years hence, it would make our task as teachers much easier. Curricula and the content of individual courses could then be planned with the exact needs of the individual and of society as a whole well in mind.

Since no one can predict with and degree of assurance what the future world will be like, about the best we can do is to proceed somewhat as we have in the past; to select a few universal values in human needs and human relationships, and then to determine the subject matter and the teaching methods which will best train the student in these universal values. After all, the outward forms of human society and government may change a great deal from century to century, but the basic human relationships and the fundamental needs of individuals and of social groups remain essentially the same through all time.

A MAN is well educated if he is in as good health as is possible for him, if he is able to make an honest living, if he exhibits good taste in his amusements and recreations and intellectual pursuits, and if he is tolerant and considerate of the opinions, ideas, and ideals of others.

The study of biology contributes to all of these ends, to some of them more than to others, to be sure, but to all of them either directly or indirectly. The teaching of health, of a love of nature, and what that may contribute to recreation and true enjoyment, and the inculcation of a scientific attitude toward nature and a tolerant attitude toward the ideas and opinions of our fellowmen, these are ends toward which the teacher of biology must constantly strive. They have always been essential needs in our various curricula and will be just as fundamental a century from now as they are today, or as they were a millenium ago.

Of course, in an age of applied science it is essential that our courses do more than lay the foundations. After the fundamentals have been stressed, their applications to modern living should be emphasized. Indeed, it is the application, rather than the basic facts, which constitute the real motivation of most of our science learning in the schools.

MY OWN field of biology has scarcely come of age. Both botany and zoology are still infants as compared with such subjects as mathematics and the humanities. The latter have had centuries in which to standardize the content of the courses and the teaching methods. It is small wonder that biology, with scarcely 125 years to its credit as a University subject and a still lesser age as a secondary school subject, is confused both in what subject matter to include in the courses and what methods to use in presentation to students. Until less than half a century ago the high school science course consisted of natural philosophy, which comprised a smattering of biology and geology together with a little chemistry and much physics. Between 1900 and 1910 these various aspects of natural philosophy or natural science became differentiated in the schools and somewhat adequate textbooks of biology, chemistry, physical geography, physics, and general science were published.

The high school texts in these scientific disciplines have improved decade by decade, especially those of general science and biology. Two things, however, are still needed. One of these has to do with the content of the courses. In the case of general science, we still need to acquire a better balance of subject matter be-

tween the sciences. Many of the general science textbooks treat of the physical and chemical world rather adequately but fall down conspicuously in considering the living world. Likewise in the biology courses the textbooks tend toward the technical side, toward morphology and classification and comparative anatomy of plants and animals, rather than in the direction of ecological relationships, fundamental likenesses in physiology in the different groups and even in animals as compared with plants, and in the practical aspects, such as gaining a familiarity with the living environment through field studies of trees, shrubs, weeds, birds, and insects. The emphasis should be placed upon common, everyday things, the environment in which the student actually finds himself.

For instance, I cannot see the value of teaching a high school student in Denver the fine points of the distinguishing characteristics of the various groups of crustaceans or of ocean kelps. Such information is of value in Denver chiefly to the specialist in the classification of animals and plants. It is much more to the point here that the student should know the common native and cultivated trees and shrubs and the common birds and insects which live right here and are a part of the everyday experience of a Denverite. Indeed, I find that many freshmen coming into my classes in botany at the University of Denver are amazed to find out that all trees with needles for leaves are not pines or cedars. And they soon find great delight in learning how to distinguish the common Colorado conifers. We have in Denver a host of trees native to the eastern deciduous forest. They are planted, of course, and only constant watering and care can make them possibilities in a climate with a limited rainfall and a high evaporation rate. But I find that our students get real pleasure and derive great profit from a study of these trees in the parks, and parkways, and on home grounds. One boy stated that when he had started to attend the University he had thought there were perhaps three or four kinds of trees, at most half a dozen kinds, but that he had learned to recognize at least 60 kinds at sight, and that he had never acquired any single bit of information which had given him so much real pleasure.

SECOND only to the importance of selecting the proper subject matter in general science and biology, the subject matter which will acquaint the student with his immediate environment, is that of improving the methods of teaching so that more will actually be learned by the student and with less expenditure of time. Sufficient time has not yet elapsed since these courses were added to the curriculum to permit a standardization of teaching method based upon experience and the scientific testing of the results of teaching. Several difficulties tend to create a more or less chaotic condition with reference to teaching methods in the courses of general biology and general science. In the first place, teachers frequently lack sufficient training in the subject matter. This is largely due to the fact that these high school subjects select data from several fields of study. General science is often said to be the poorest taught of any high school subject, with general biology a close second. The good teacher in general science must have had adequate training in zoology, botany, human physiology, chemistry, physics, geology, astronomy, and anthropology, at the very least. The subject matter included in general biology is somewhat less inclusive, to be sure ,but in any case the good teacher of the subject must have had adequate training in the fields of botany, zoology, and human physiology. In this day of specialization it is difficult for any one person to be sufficiently well trained in so many different sciences. Often the teacher is much better trained in the physical than in the natural sciences. This is bound to be reflected in his teaching, for he will overemphasize the physical and minimize the importance of the natural sciences. Often the teacher of general biology is better trained in either botany or zoology, usually the latter, and altogether too many times the course in general biology becomes largely a technical zoology course.

IN THE second place, the newness of these subjects in the curriculum of the high schools has resulted in the following of the

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A Lecture Experiment to Illustrate the Use of the Scientific Method in Arriving at a Law

By EVERETT R. PHELPS

Wayne University

Detroit, Michigan

DURING the summer of 1941, the author acted as science consultant for the "First Michigan Teacher Education Workshop." Several panel discussions on various topics concerning the teaching of science were held. At one of these the subject was: "Teaching Students to Use the Scientific Method", and the following statements were agreed upon regarding the application of the scientific method to the solution of a problem.

1. Study a situation to recognize the exact problem involved.
2. Obtain as much data (experimental and otherwise) as possible which is relevant to the problem.
3. Set up a hypothesis for the solution of the problem.
4. Attempt to solve the problem by applying the hypothesis to the data obtained.
5. Critically examine the solution to see if it satisfies all aspects of the problem. Check that the conclusions which follow from the solution are in accord with known facts.
6. If there is a single contradiction between the solution and known facts, the solution must be discarded and the data reexamined in terms of a modified or new hypothesis.
7. When a solution is obtained which seems to be satisfactory in all respects, accept it and act on it.

TWO CLASSICAL examples of the use of this type of reasoning in arriving at laws are: (1) Kepler obtaining his laws of planetary motion from the observational data of Tycho Brahe, and (2) Newton arriving at his statement of the law of universal gravitation from Kepler's laws and various experimental and observational data.

In the Wayne University course in physical science (for pre-teaching students), rather than stating Boyle's law and discussing its meaning and use in the usual manner, the author attempts to show how the law may be arrived at by employing the scientific method in the following manner:

1. The problem to be studied is the relation between the volume of a gas and the pressure of the gas when the temperature is kept constant.
2. Experimental data are taken with the aid of a "J"-shaped glass tube of uniform cross-section area, mercury, and a meter stick, as follows:

Pour in just enough mercury (levels 1 and 1′) to trap air in the short closed end of the "J". In the tube used by the author, the distance from the 1 level to the top of the short arm of the "J" was found to be 15 cm, and the distance from this 1 level to the top was graduated in centimeters (0 to 15) and marked on the glass with special crayon. The volume V_1 of the enclosed air is thus $V_1 = 15a$, where "a" = cross-section area of the tube. The corresponding pressure of this gas in cm of mercury $= P_1 =$ barometer reading, for, since levels 1 and 1′ are horizontally opposite, the pressure of the enclosed gas equals the pressure of the atmosphere, which in turn is given by the barometer. On one particular day the barometer read 75 cm of mercury, so $P_1 = 75$ cm.

Enough mercury is now poured in to bring

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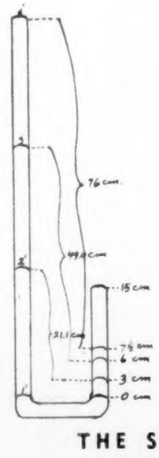

Diagram of J-tube and experimental trials

Fiber Identification Stains

HARRY LEVIN

Washington Irving High School — New York City

STUDENTS of high school chemistry and merchandising as well as textile consumers are now able to identify textiles by staining them with one of the fiber identification sets now available. Place a drop of the fiber identification stain on a sample of white or bleached fabric. A distinctive color change is produced for each fiber. Compare this color change with the identification table listing enclosed with the set and the fiber has been identified. When dyed fabrics are to be identified the color must first be stripped and the stripping agent thoroughly washed from the fabric.

The fiber identification stain lends itself readily for use as a laboratory exercise on fiber analysis.

We have been familiar with the differentiation between animal and vegetable fibers by the use of picric acid. The yellow stain resulting may be washed out of cotton and linen but is retained by wool and silk. G. Hahn of the National Aniline Co. applied picric acid to the artificial rayon fibers and found that acetate rayon retained the yellow color, while the cuprammonium and viscose rayons were unaffected. He developed the first stains for the quick identification of rayons. The following stains were developed by Hahn and now bear his name.

Hahn's Stain

Solution A 1% Picric Acid 0.2% Soluble Blue 2B Extra
Solution B 1% Tannic Acid 0.2% Soluble Blue 2B Extra 0.1% Eosin

	Effect on Acetate Rayon	Cuprammonium Rayon	Viscose
Solution A	Yellow	Deep Blue	Pale Blue
Solution B	Colorless	Deep Blue	Lavender

Davis and Rynkiewicz of Johnson & Johnson Laboratories varied the concentration of dyes used by Hahn and substituted acid fuchsin for eosin. They report the following:

Stain developed by *Davis* and *Rynkiewicz*

Acid Fuchsin	Color index No. 692	6 gms.
Picric Acid		10 gms.
Tannic Acid		10 gms.
National Soluble Blue 2 Extra	Color index No. 707	5 gms.

Dissolve in hot water in any order and dilute to 1 liter.

Momentary immersion in hot solution is sufficient.

3 minutes for cold dyeing. Rinse thoroughly in water.

Press wet between white absorbent papers. The results are:

Cotton or Linen	Light Blue
Acetate	Light Yellow
Nylon	Greenish Yellow
Cuprammonium	Dark Blue
Viscose	Lavender
Wool	Yellow
Silk (raw)	Black
Silk (degummed)	Brown

Commercial identification sets are obtainable as follows:

(1) Colotex B a fiber identification stain sold by the McCabe Chemical Co., Irvington, N. J. produces the following results. A color chart for color comparison accompanies each set. The following results are claimed:

Viscose—Lilac
Silk—Reddish Tan
Acetate—Lemon Yellow
Cotton—Blue Violet
Cupprammonium—Reddish Blue
Wool—Orange Brown
Silk—Reddish Tan
Nylon—Reddish Yellow
Linen—Bluish Mauve
Vinyon—White
Aralac—Red

(2) Texachrome and Texstrip—4 oz. of each are contained in the fiber identification set sold by Eimer and Amend for $3.50 per set —635 Greenwich Street, New York City.

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Science for Society

EDITED BY JOSEPH SINGERMAN

• **A department in which science is presented in its close relationship to the individual and in which guidance is given in causing the individual to recognize the methods of science and its vast social implications.**

Medical Care

DR. JOHN PETERS

Yale University New Haven, Connecticut

In this article, Dr. John Peters, Professor of Medicine at Yale University's School of Medicine and Secretary of the Committee of Physicians for the Improvement of Medical Care, gives his views on the quality of present medical care, and suggests how it might be improved. (Condensed from Consumer Reports, a publication of Consumers Union, New York City).

THE CHIEF sources of controversy within the medical profession and between physicians and the public arise from two misconceptions. The first of these is the general opinion that the chief function of medicine is distribution. The second is the failure of the medical profession to appreciate fully that medicine is intended primarily for patients, not for physicians.

The undue emphasis placed upon distribution arises naturally from the fact that medical care until very recently consisted of personal services of a simple character, requiring little equipment, either physical or intellectual. This tradition is reflected in the prevailing system of private practice and in most public systems of medical care that have thus far been established. It is even evident in the latest legislative proposal for a health program, the Wagner-Murray-Dingell Bill.

IN THE program of current medical education, in the hands of the military authorities, postgraduate medical education has been almost abolished! internships have been cut beyond the danger point; medical students have been subjected to a great leveling procedure. A system designed to provide medical officers for an emergency has been so planned that it may jeopardize the quality of medicine for a generation.

This military program has met with little opposition for several reasons. Physicians as a whole have been organized as practicioners, not as educators and investigators. Their spokesmen and leaders have not included the latter. Most medical educators and investigators have held themselves aloof from public life as if they were too precious for the role of citizenship. Practitioners, educators and investigators alike have failed to teach the people that this medicine for which they clamor has acquired other ingredients than the shingle on the door, the little black bag and the empiricism and bedside manner such things symbolize.

All this began at the very moment when it was becoming evident that medicine was not meeting the implications of modern science, that the gap between its potentialities and its accomplishments was continually increasing, that the public was deriving but a small part of the benefits that modern medicine was prepared to offer.

ONE OF THE chief reasons for this discrepancy has been the lack, among physicians, of the basic scientific education that could give them an understanding of the new means of diagnosis and therapy which chemistry and physics have put at their disposal. Individualized, competitive private practice in isolated offices has excluded them from the contacts that could keep them aware of new ideas and methods; it has deprived them of the time and facilities that would allow them to participate in the development of new ideas and methods.

Resources Help Advance

American medicine has assumed the leadership in medical science because America has

been blessed with resources and comparative peace. To ascribe our scientific contributions to our system of medical practice is, however utterly unrealistic. Scientific investigation requires organization, facilities, equipment and technical assistance that the private practitioner cannot command. More and more contributions to medicine are coming from full-time, salaried workers in institutions supported by the government, private philanthropy or commercial organizations. In fact some of the leading medical investigators do not even possess an M. D. degree.

THE PRACTITIONER is assuming an ever more derivative position as a dispenser, not a maker, of medicine. He relies on rules of thumb gleaned from occasional lectures at medical societies, refresher courses, or advertising literature issued by commercial drug firms or instrument makers. The physical, chemical and physiologic principles that should govern the use of new drugs, instruments and procedures are beyond his grasp; the directions for their use and discussions of their meaning must be simplified or they are beyond his comprehension. If this course of development is not soon checked physicians will be relegated to a position not far above that of salesmen.

The best students in the leading schools and teaching hospitals have tended steadily to prolong their educational courses to include residenceships and research fellowships. But hard economic facts of our social organization have limited their ambitions. Real careers in teaching or investigation, in the clinic or in the laboratory have been rare. These men know that their economic days are numbered, that they will soon be driven by sheer economic necessity to terminate their endeavors in the maelstrom of practice. They therefore eschew fundamental inquiries, preferring some more trivial pursuit that will be of immediate advantage to them.

THE SAME attitude has dominated the whole educational course. Students tend to seek what they term *practical*, not realizing that they mean *immediately exploitable*, and that the immediately exploitable is inevitably transitory. They seek not a background on which they can build nor instruction in methods of learning; but only context which will send them into practice as polished models, dated with their year of graduation. In this they are abetted by the example of their most successful clinical teachers, whom they emulate.

The last war congealed at its inception a move to reorganize medical education that would have been inevitably reflected in the system of practice. Growth had to give way before the urgent need for preservation and for reconstruction, to which no thought had been given. Just before the present war a new ferment of dissatisfaction was expressing itself in educational and investigative efforts and in programs for the wider distribution of medical care. Again it bids fair to die a-borning. But this time, because the emergency and the waste are greater, the problem of reconstruction will be harder. Besides, the gap between potentiality and accomplishment in medicine has widened steadily because science has advanced, while our system of medical practice has stood still.

OUR BEST present educational equipment has failed to keep our physicians abreast of the times. Nevertheless, the medical youth for the last few years has been propelled into the military forces without even this scanty background. What shall be done with this geenration of doctors after the war? To throw these young men into the melee of private practice without further training will be a gross injustice to them, and can only result in the further degradation of the whole system of medical care. The medical schools and teaching hospitals cannot take them all back to complete their studies as many naively suppose. These schools and hospitals, with their usual heavy responsibilities and their usual meager facilities, will be quite unable to assume this additional burden gratuitously.

Besides, after a lapse of years with their accumulation of responsibilities, these young doctors can not resume life just where it left off; they will not consent to revert to a status in which they are inferior to their juniors. They cannot afford to live as internes and residents without remuneration even if opportunities are made for them.

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Science Clubs at Work

Edited by DR. ANNA A. SCHNIEB

State Teachers College — Richmond, Kentucky

• A department devoted to the recognition of the splendid work being done by the science club members and their sponsors in the various State Junior Academies of Science. Material for this department, such as student made projects; demonstrations and posters; outstanding club programs; state and regional meeting announcements; should be sent to Dr. Schnieb.

Versatility of Science Clubs

M. P. SMITH

Bunsen Club, Atherton High School — Louisville, Kentucky

THAT science clubs make it possible for teachers to recognize individual differences is shown by the following pictures which represent some of the kinds of work carried on by The Bunsen Science Club, Atherton High School, Louisville, Ky. Each picture shows that a particular interest and a need was met. It was not a project just for the sake of a project, but it was an activity carried on for the sake of finding out definite, usable information. Each student saw with her own eyes. As John Locke says: "I can no more know a thing from another man's understanding than I can see with the other man's eyes."

Purple cabbage can be used as an indicator as effectively as litmus or phenolthalein. The purple liquid, obtained from boiling the cabbage leaves, will turn red in the presence of an acid and yellow in the presence of a base.

The purple color of cabbage is here used as an indicator

THE FLAG has been painted with a solution of potassium ferro cyanide to represent the field of blue, and with a solution of sulfo cyanide to represent the red stripes. When these chemical compounds are moistened with a solution of ferric chloride they turn blue and red respectively. Thus with the compounds "Old Glory" is formed.

Red and blue of the flag are produced by applyin· ferric chloride to compounds in the cloth.

To determine whether the milk contains the 3.2% butterfat required by the government, a prescribed amount of concentrated H_2SO_4 is added to a definite amount of milk in a Babcock bottle and then is whirled in the Babcock Tester in order to release the butterfat. The fat, being lighter, rises to the top and can easily be read.

These students are determining the butterfat in milk by the Babcock method.

THE DOLLS shown in the picture are dressed in material dyed from the coloring matter in soft drinks. Wool, cotton and linen are the materials used. Wool absorbs the dye more readily than the cotton and linen which are only lightly dyed. It is necessary to boil the materials in the soft drinks in order for them to pick up the coloring matter.

In studying fats in connection with the war effort, the question of soap arose. The soap was prepared by heating a mixture of lye and fat. This resulted in soap and glycerin which is so valuable in the making of explosives and other products valuable to the war effort.

Dyes from soft drinks are here used to color doll clothes.

Soap is made from fat and lye.

FIBER IDENTIFICATION

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(3) Textile Identification units may be obtained by sending 50 cents to Science News Letter—1719 N St. N. W., Washington 6, D. C.

(4) National Aniline Division—Allied Chemical and Dye Corp.—40 Rector St., N. Y. makes an excellent fiber identification stain.

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Experiments in Plant Nutrition

By GEORGE McCUE and BERNARD DELL
Southwest High School St. Louis, Missouri

SEVERAL members of the Anderson Chapter of the Junior Academy of Science in keeping with the theme, Nutrition, chosen as a semester subject by the Chapter, carried on an experiment to determine how a lack of vital minerals affects a plant's growth.

On February first, sixty days before the experiment had to be completed, 48 tomato seedlings were planted, six in each of eight pots, one of these to serve as a control, each of the others to be used to demonstrate a deficiency in calcium, potassium, nitrogen, magnesium, phosphorus, sulfur, and iron.

Tomato plants were chosen as the medium of experimentation for several reasons: (1) having a small seed, they could not have large quantities of minerals stored which might affect the result, (2) they were readily obtainable, (3) they grow fairly rapidly.

A SAND medium of boiled, clean, river sand was used for all pots except the one for calcium, which was grown in sterile, clean, white sand because it was found on testing, that the river sand contained a small quantity of calcium.

Distilled water was used in all cases and Chemically Pure or Analytical Reagent grade chemicals were used. None of the trace elements (boron, zinc, etc.) were added as enough could probably be obtained through impurities.

Sunlight was a premium during the early spring months. However, the plants had all available.

The formulae were taken from Phillip's *Gardening Without Soil*. Where the chemicals called for were not available, substitutions were made. However, approximately the same number of ions of each of the elements was present in the finished solutions. The eight solutions were each kept in different jars and smaller bottles were used for watering. Each of the pots was kept in a labeled, enameled tray and each pot, jar, and bottle was carefully numbered.

Results were satisfactory in all cases except the magnesium. The calcium deficient plants showed decidedly stunted growth, being in cases less than a third as tall as the control. The leaves turned brown and eventually died, as did the plant itself, thus demonstrating that calcium is necessary for normal leaf, root, and stem development, since it gives tone and vigor to the plant.

IN THE CASE of the potassium deficiency, the plants, too, were smaller than the control to a marked degree and some chlorosis was evidenced, for potassium is necessary for photosynthesis and the changing of the sugar formed into starch.

Since nitrogen is a tissue builder and is very important to plants with large leaf surfaces, lightness of color in comparison to the control and a dwarfing of the plants was observed in the nitrogen deficient plants.

Magnesium was lacking in one of the plants, but no marked difference was noticeable; however, it acts in the formation of chlorophyll and takes an active part in the formation of fats. When a plant is deficient in magnesium, usually, there is a general chlorosis, mottling and curling upward of the leaves.

A DISTINCT purple color and smallness was noted in the phosphorus deficient plants. Since phosphorus is necessary to extract nitrogen from the various nitrates the plant takes in, a lack of phosphorus often causes a nitrogen deficiency.

The sulfur deficient plants were stunted and developed woodiness in the stems and leaves. Sulfur is essential in the production of proteins in the plants and is important especially to crops containing large amounts of proteins.

In the iron deficiency, of course, there was a general chlorosis.

Problems encountered in addition to the ones mentioned in the beginning were:

1. White fly infestations on a nearby group of irreplaceable, cholchicine treated tomato and lettuce plants.

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Above left, Jules Kernen, Wray Darr (center), and William Brohammer (right) feeding and watering their white rats. Upper right, Jules and Wray weighing a rat for statistical purposes.

To the left, Bernard Dell, pollenating the experimental tomato plants and George McCue (right) regrouping the radishes.

A Series of Experiments in Animal Nutrition

By JULES A. KERNEN
High School Student
Southwest High School St. Louis, Missouri

IT HAS BEEN customary during the last several years for each member of the Biology Club at Southwest High School to select some topic for scientific study throughout the year. In the autumn of 1943 several of the members became intensely interested in animal nutrition and, therefore, decided to conduct some experiments of their own upon albino rats.

The rats upon which the experiments were conducted were pure white in color, about two weeks old, were approximately forty grams in weight, and had been pure-bred in a laboratory. One half of theme were male; the other half, female. The individual rat cages were about a one foot cube constructed of wood with a wire mesh covering. All of the food and water containers were made of glass. This material was thoroughly cleansed each day and was sterilized once a week in hot Lysol water.

AT FIRST an attempt was made to secure pure foodstuffs, such as: gluten, milk powder, etc., but, due to priority ratings and exceedingly high prices, it was impossible to do so. After much thought and deliberation, several foods were selected which were unrationed, inexpensive, and available in every home. They were: cornmeal, lettuce, a vegetable which was varied daily, milk, salt, and cod liver oil. All of the experiments were conducted merely by varying this stock diet.

In order to understand thoroughly the results of the experiments, it is necessary to know a few fundamental facts concerning the action of the various food requirements.

THE CHIEF constituents of any diet are fats, carbohydrates, proteins, minerals, and vitamins. Although the foregoing are very different in action, not one of them can be omitted from a healthful diet. Fats and carbohydrates are used primarily for energy and heat production; whereas proteins are used in the building and repairing of body tissues. There are a number of minerals necessary in a healthful diet, among which are sodium, chlorine, phosphorus, iron, and calcium. They perform many and diverse functions, among which are the builidng of sound teeth and bones, the regulation of heart, nerve, and muscle functions, and coagulation of the blood. The large and constantly expanding "Vitamin Family" also has myriad duties, some of which are the protection of the body against bacteria and the regulation of metabolism.

AS HAS BEEN said earlier, the entire series of experiments was conducted merely by varying a stock diet. All of the rats, however, were first given this diet for a few days, so that they could recuperate from their long journey from the dealer. Rat A received two tablespoonfuls each of cornmeal and lettuce, and a small amount of salt daily. This diet was deficient in protein, iron, calcium, copper, and Vitamin D. The results obtained were truly remarkable. On January 19, it weighed 37.2 grams, as can be seen in the accompanying table. For four weeks thereafter it showed an average weekly gain of about three grams, increasing from 37.2 grams to 40.1, 42.7, 46.8, and 47.85 respectively. Besides being extremely thin, this rat was suffering from a bad case of the rickets, weak eyes, thin hair, a nervous disposition, and some sort of a skin disease on its tail. On February 21 it was near death; so it was given the stock diet thereafter. Immediately it began to gain weight—about nineteen grams the first week and an average of about eighteen grams a week thereafter. Its weight increased from 47.85 grams to 66.5, 93.2, 112.0, and on March 17 it weighed 120.2 grams. By this date all of the disease symptoms had almost entirely disappeared, showing that, even if one is near death from a deficiency disease, it is entirely possible to recuperate if a healthful diet is again resumed.

Rat B received daily for the entire experiment two tablespoonfuls each of cornmeal and milk, and a small amount of salt. This diet was deficient in iron, copper, and Vitamin E. Since Rat B received an oversupply of cornmeal in proportion to the total amount of food eaten, it began to grow excessively—an average of about twenty-five grams a week—until by the end of February it had become much too fat. It increased from 47.6 grams to 74.5, 96.2, 110.5, 126.9, 142.4, 155.3, 164.9, and on March 17 it weighed 167.6 grams. By March 3 it had practically reached maturity, so after that date it gained an average of only about six grams a week. Even this rat, however, received a diet which was deficient in some mineral or vitamin that caused it to suffer from the very same skin disease that had affected Rat A. This experiment conclusively demonstrates that it is almost as unhealthful to eat an oversupply of carbohydrates as it is to eat too little of them.

Rat C received daily two tablespoonfuls of cornmeal, milk, and lettuce, and a small amount of salt. This diet was deficient in iron and copper; however, a lack of neither of these two minerals has serious consequences; so Rat C gained almost normally in weight—an average of about sixteen grams a week. It increased from 46.0 grams to 62.4, 80.8, 98.5, 116.3, 138.3, 149.0, 159.9, and on March 17 it weighed 171.2 grams. This rat showed no definite disease symptoms.

Rat D received daily two tablespoonfuls each of cornmeal, lettuce, milk, and a vegetable which was varied each day, and a small amount of salt. This diet contained a sufficient supply of all important food elements; so after February 14 it was not given milk. After this change, the diet was deficient in Vitamin D, calcium, protein, fat, and copper. Before the change in diet the rat gained an average of about fourteen grams a week. After the change, however, it averaged only about five grams a week. It increased from 40.6 grams to 49.9, 71.4, and 83.7 grams. Then came the change in diet. In the succeeding weeks the rat increased in weight as follows: from 83.7 grams to 82.1, 87.5, 92.5, 93.7, and on March 17 it weighed 108.6 grams. This experiment illustrates pointedly the absolute necessity of including milk in a healthful diet.

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The Science Program in the Upper Grades

ALBERTA L. MEYER

Hempstead Elementary School — St. Louis, Missouri

BEING asked to discuss so large and comprehensive a subject as *The Science Program in the Upper Grades* in one session is somewhat akin to attempting to learn to play the piano, as the advertisements say, in six easy lessons. You must not expect too much of either.

Basic Principles

Isn't it true that there must be certain basic ideas in *all* elementary school science teaching, from kindergarten on up? Most of us would probably agree that upper grade science teaching must, of necessity, build on the work of the lower grades. As in any other subject, this becomes more difficult if the basic ideas underlying the teaching are not the same throughout the grades.

Wouldn't you agree with these basic principles?

1. We study science in the elementary school to help the child grow in his understandings.
2. We study science in the elementary school to help the child develop a way to tackle his problems.
3. We study science in the elementary school to help the child appreciate the value and place of science in our modern world.

Let us examine these three basic principles a little more closely.

1. In the first of these, to help the child grow in his understandings, please notice the word is "understandings", not "knowledge." Of course, growth in understandings requires a knowledge of facts, but facts, alone and unrelated, do not make for understandings. Of course, content is important; indeed, there is not much teaching without it; but content is a means to an end, not an end in itself.

FOR EXAMPLE, frequently at the beginning of a term, the children and I discuss what questions they would like to try to answer in science. Very often, when a certain subject is mentioned, someone will say, "Oh, stars! We studied *that* in Miss X's room." This is said with such a tone of finality that you know to that child the subject is exhausted. He thinks he knows all there is to know about it.

To me this indicates two things: first, stars (or whatever the topic may be) were studied too exhaustively in the lower grade; second, content was over-emphasized, so that little real growth in understanding took place. If this were not so, the child would at least be left with the attitude, "My, there is a lot to learn about stars! Why, even the scientists are still trying to find out more about them."

2. The second basic principle is, we study science in the elementary school to help the child to develop *a way* to tackle his problems. This way is the way of science; the scientific method, if you will. In its simplest form, this means defining your problem, suggesting possible solutions for it, experimenting or trying out the one that seems most likely, and checking the results. Can children use the scientific method? Yes, with guidance. And not in science only, but whenever a problem needs to be solved. It is the teacher's job to be on guard continually for instances of failure to think clearly, for tendencies to generalize from too little evidence, for glib acceptance of superstitions.

THERE are too many examples of shoddy thinking. Here is one. In a class discussion about the Negro, there was an instance of generalizing from one experience. Jim related how he, in a crowded bus, got up to offer his seat to an elderly lady. As he did so, a very able-bodied Negro woman slipped into his place. He protested, "I wanted this lady to have my seat!" The reply was, "Did you? I thought you were getting out," and the Negro woman continued to sit. Jim was indignant, and ready to project his unhappy experience into an unfriendly attitude toward a race. He was brought up short by the question, "Have you ever seen a white person do something like that?" Forced to admit he had, he was helped to see that it is unfair and unscientific to judge a group by the action of only one of its members.

3. Third, we study science in the elementary school to help the child to appreciate the value and place of science in our modern world. Perhaps 1% or less of the children in our elementary classes will grow up to be scientists, but all of them now live and will continue to live in a world increasingly modified by science. To see and appreciate what

science has done to make our lives more convenient and more healthful, and to know that science *now* has the knowledge to make an abundant life possible for everyone, is something every citizen should understand. Science has the knowledge if we will but use it.

An appreciation of science is comparatively easy to teach, for almost every day our newspapers report new discoveries in science which are helping to save the lives of wounded soldiers. Children are tremendously interested in the sulfa drugs, penicillin, and atabrine. This is just one field in which science is of great value to us, and it is comparatively easy to stress the need for the complete freedom of research which produces such discoveries.

How We Attempt to Achieve These Basic Principles

TWO YEARS ago, after long consultation, the teachers of the four upper rooms at Hempstead agreed to abandon the departmentalized system then in use, and, for the most part, work with one group of children all day. If, however, one teacher felt that another could do a better job of teaching a particular subject, she was free to work out an exchange with her. It was for this reason that Iris Guenther and I exchanged music for science. In similar fashion, other exchanges were worked out between other teachers. Thus we at Hempstead have tried to secure all the values of an integrated program plus the benefits of special skills and training of individual teachers. Since our set-up is a kind of "hybrid", there is no value in debating the issue between departmental and non-departmental systems. There are, however, a number of values in the way this scheme works out:

1. The children have the benefit of better teaching and richer background from the teacher with special training.

2. It is possible to develop a modified form of the "core" curriculum, for which the teacher must have large blocks of time at her disposal, and must be free to draw from any subject-matter field to further the work of her group.

ONE CLASS which made a study of aviation is an example of such integration. In history, they compared the major events of American history with those of aviation. In English, they read stories, poems and books about flying; they learned to spell words concerned with aviation; they wrote about what they had read; they prepared a program covering all phases of the subject. Science, too, played its part—air and its properties, the natural flight of birds and animals, weather, the composition of the atmosphere, maps, balloon flights, the principles of heavier-than-air flight, and the controls of an airplane were all studied.

3. Such a program enables the teacher to use a completely flexible time schedule. There is no need to stop with the bell when some very interesting idea is developing, or when an experiment takes a little longer than expected. Nor is it necessary to fill in a period with trivialities when a lesson is finished sooner than expected.

4. With such a set-up, it is possible to utilize children's experiences and interests, which only the classroom teacher is likely to know.

FOR EXAMPLE, a number of boys in my room were found smoking near the school. After the state regulations and the Board of Education rules regarding smoking were explained to them, a discussion arose one day as to the reasons why one should or should not smoke. The boys were asked if they would like to find out what the scientists say about smoking. The response was quite enthusiastic from the smokers; less so from the non-smokers. (That's interesting, isn't it?) After a thorough search of all available books and encyclopedias, the arguments for both sides were listed in parallel columns. This served to accentuate the fact that smoking offers few if any advantages, particularly for growing boys and girls. James summed up the discussion thus: "Smoking doesn't do anybody any good. Kids just start smoking 'cause they see others doing it." I am not deluded into thinking this brief study would cause James and others like him to give up the smoking habit, but at least they were able to face the facts realistically and know the possible consequences of continuing the habit. That to me made it worth the time.

Here is another example of utilizing a current interest. Someone reported in current events that there was a baby volcano in Mexico just about a year old. This brought on a flood of questions about the cause of volcanic eruptions, etc. The class was asked if they would like to make a brief study of volcanoes; they agreed and the project was undertaken. Very obligingly Vesuvius erupted just at this time and helped make our study even more interesting. Charts were made to show the interior of a volcano; a blackboard map was

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LECTURE EXPERIMENT

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the level in the short arm of the "J" to the 3 cm mark called level 2, making the second volume $V_2 = 12$ a. The corresponding level 2′ in the open tube was found to be 21.1 cm above the level 2. The pressure of the enclosed gas thus exceeds atmospheric pressure by 21.1 cm so $P_2 = 75 + 21.1 = 96.1$.

Mercury is again poured in to make a new level at 3 at the 6 cm mark, giving a volume of enclosed air $V_3 = 9$ a. The corresponding level 3′ is found to be 49 cm above the level 3, so the pressure of the enclosed gas now exceeds atmospheric pressure by 49 cm of mercury, or $P_3 = 75.0 + 49.0 = 124.0$ cm.

A fourth trial is carried out by adding mercury to make level 4 at 7.5 cm, in which case level 4′ is found to be 76 cm above level 4. so $V_4 = 7.5$ a and $P_4 = 75.0 + 76.0 = 151.0$ cm.

3. In considering possible hypotheses, the volume of a gas (temperature constant) might vary directly as the pressure, directly as the square of the pressure, etc., or inversely as the pressure, inversely as the square of the pressure, etc. Since the volume is seen to become smaller as the pressure increases, none of the direct relations is possible. Of the various inverse relations, let us first try out the simplest. So our hypothesis is: At constant temperature, the volume of a given mass of gas varies inversely as its pressure.

$$\frac{V_2}{V_1} = \frac{P_1}{P_2}, \quad \frac{V_3}{V_1} = \frac{P_1}{P_3}, \quad \frac{V_4}{V_1} = \frac{P_1}{P_4}, \quad \frac{V_3}{V_2} = \frac{P_2}{P_3}, \text{ etc.}$$

Trying these out in order:

$$\frac{V_2}{V_1} = \frac{P_1}{P_2} \text{ gives } \frac{12.0 \text{ a}}{15.0 \text{ a}} = \frac{75.0}{96.1}$$

or $.800 = .780$

$$\frac{V_3}{V_1} = \frac{P_1}{P_3} \text{ gives } \frac{9.0 \text{ a}}{15.0 \text{ a}} = \frac{75.0}{124.0}$$

or $.600 = .605$

$$\frac{V_4}{V_1} = \frac{P_1}{P_4} \text{ gives } \frac{7.5 \text{ a}}{15.0 \text{ a}} = \frac{75.0}{151.0}$$

or $.500 = .497$

Although the above ratios do not exactly agree, they do agree within reasonable experimental error. It is pointed out that the sufficient to justify our concluding that the hypothesis is correct. Hundreds of above few experiments of course are not carefully performed experiments would have to be carried out.

5. According to the kinetic molecular theory, if the volume of a given mass of gas is made smaller with the temperature kept constant (same average kinetic energy of the molecules), the same number of molecules are crowded into the smaller volume. This means that the molecules having shorter paths between confining walls will strike the walls oftener thus increasing the pressure. Hence, the results of this accepted theory are in accord with our hypothesis. Many other similar agreements (or disagreements) should be looked for.

6. Had we first tried the relation—volume varies inversely as the square of the pressure, we would have found that our experimental results would not have supported the hypothesis, in which case it would have been discarded, and a new or modified hypothesis set up and examined.

7. Our hypothesis that "the volume of a given mass of gas varies inversely as the pressure of the gas" having been upheld by the results of many carefully performed experiments, and having been shown to agree with the results of other accepted theories (e. g. the kinetic molecular theory) and known facts, would now be accepted as a working hypothesis. The relation can be made use of to compute: the weight of gases generated in laboratories under other than conditions of standard atmospheric pressure; the pressure of the air in a diving bell; the expected expansion of air in a balloon at various elevations (temperature effects are also involved in many cases); etc.

   After years of use without the discovery of any contradictory phenomena, our hypothesis would probably be dignified by the term "law."

Free Moving Pictures in Science

MAE BIRDSONG

Waycrosse High School **Waycrosse, Georgia**

The following list gives the names and addresses of free films which are available for all high schools. The only expense involved is the transportation fee, and in some cases the company pays this.

The Metropolitan Life Insurance Company has some excellent films on health which are appropriate for biology, chemistry, and home economics. This company will pay expenses of transportation both ways on the films.

In our own state of Georgia, the Departments of Entomology, Forestry, and Health will send to any high school in the state a representative from the department, who will bring films and his own machine to show pictures pertaining to these fields. There will be no expense whatever to the school. The teacher should write to the head of the department and make arrangements for this, if it is desired. Usually films can be secured free for schools through the Farr Demonstration Agent, and other county agents.

If teachers desire any films listed below, they should write to the companies and make arrangements for bookings as soon as possible in the year, because they are always in demand.

Free List of Moving Pictures in Science

Biology

1. "Alaska's Silver Millions," American Can Co., 230 Park Ave., New York.
2. "Florida Citrus Industry," Dr. Phyllips, Orlando, Fla.
3. "Man Against Microbes," Metropolitan Life Ins. Co., New York.
4. "Pay Off," W.C.T.U., Atlanta, Ga.
5. "Romance and Meats," Castle Films, New York.
6. "Trees to Tribunes," Chicago Tribune Pub. Co., Chicago, Ill.
7. "While the City Sleeps," Ford Motor Co., Dearborn, Mich.
8. "Voices in Paper," Southern Bell Pictures, Hurt Bldg., Atlanta, Ga.
9. "Fish and Fishing," South Bend Bait Co., South Bend, Ind.

General Science

(The first ten are all obtainable from Southern Bell Pictures, Hurt Bldg., Atlanta, Ga.)

1. "Voices in the Air"
2. "Communication News and Views, Series 2"
3. "Network Broadcasting"
4. "Seagoing Telephone"
5. "Switchboards—old and new"
6. "Underwater Speechways"
7. "The Voice that Science Made"
8. "Voices in Paper"
9. "Far Speaking"
10. "Looking into Metals"
11. "Science Rules the Range," Ford Motor Co., Dearborn, Mich.
12. "Television," Wm. J. Ganz, 19 E. 47th St., New York
13. "Volt Comes into Its Own," Gen. Elect. Co., Red Rock Bldg., Atlanta, Ga.
14. "Light of the Race," same as No. 13
15. "Air Waves," Wm. J. Ganz, 19 E. 47th St., New York
16. "Eighty Years," same as No. 15

Chemistry and Physics

1. "Footsteps," Wm. J. Ganz, 19 E. 47th St., New York
2. "Brighter Times Ahead," General Electric, Red Rock Bldg., Atlanta, Ga.
3. "Excursions in Science," same address as No. 2
4. "Carbon Monoxide—The Unseen Danger," U. S. Bureau of Mines, Washington, D. C.
5. "Men and Machines," Natl. Assoc. of Mfgs., Public Relations Dept., 14 W. 49th St., New York
6. "School Goes to the Farm," State Voc. Agr. Dept., Atlanta, Ga.
7. "Wonderworld of Chemistry," Dupont Co., Wilmington, Del.

Under Biology Numbers: 3 and 7.

Under General Science Numbers: 3, 4, 10, 12, 15, and 16.

FREQUENCY MODULATION

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result of the lower noise level of FM. It is quite possible to design AM receivers to have fidelity characteristics very nearly equal to those of the present day FM receivers, but in so doing, the effects of noise and adjacent channel interference are greatly increased. The four characteristics of a transmission system that determine its fidelity are (1) the uniform audio frequency response range, (2) the amount of wave form distortion, (3) the dynamic range, and (4) the noise present.

Because of the low noise level of FM, it has become possible to standardize an audio frequency response range from 40 cycles to 15,000 cycles. This encompasses the entire usable audible range. In contrast, the average AM receiver has a range of from 40 cycles to 4,000 cycles. Some high quality instruments show up better than this, and "midget" sets show up considerably worse. The difference is readily apparent to the untrained listener.

There is no reason why there should be any superiority with respect to wave form distortion in either system. Actually because more money and finer design is being put into the average FM receiver, it is far superior to the AM receiver. This is purely a design problem and has no bearing on whether the system is AM or FM.

The dynamic range of FM transmission is definitely superior to that of AM. The range in level of transmitted music from the softest pianissimo to the loudest forte is about 75 decibels. The necessary part of this range can be transmitted by FM. In AM the range must be reduced to one half that value because noise limits the lowest level that can be transmitted, and 100% modulation limits the highest level. Neither of these restrictions are important in the FM system, so that it is not necessary to "ride the gain" to bring up the low passages and cut down the high when transmitting music.

THE THIRD advantage attributed to FM is less common channel interference. Anyone who has tried to pick out a low power station in the high frequency end of the broadcast band will realize how bad common channel interference can be on AM transmission. The reason is that the interference range of a station goes far beyond the actual usable range of the station. There are not enough channels to accommodate each station on a separate frequency, so such common channel interference on the broadcast band is the result. In FM there is practically no common channel interference. The stronger of two signals received on the same frequency predominates, and if the ratio of signal strengths is greater than 2:1 the weaker signal cannot be heard at all. In AM transmission the ratio of desired to undesired signal must be 25:1 to prevent interference. Furthermore, the propagation of high frequency waves such as used in the FM bands is such that there is no sky wave which causes interference at great distances at night.

The fourth advantage, and in some ways the most important, is the result of the revolutionary character of the new FM system. Both transmitters and receivers must be changed to use FM. The radio broadcasting industry has had a mushroom growth in the past twenty three years, and both broadcasters and manufacturers have indulged in some rather bad habits as the result of commercial expediency. Commercial programs in attempting to satisfy the "popular taste" have actually established many undesirable "popular tastes." The Soap Opera, the singing commercial announcement, and the contest type of program are a few examples of poor program practices which broadcasters introduced to create a popular taste. Manufacturers have for the past 12 years been cutting corners in the receiver field. The midget set which cannot possibly reproduce music with any semblance of fidelity, gadgets such as push button tuning, remote control, etc., have been introduced to increase set sales. The competition became so fierce that the high quality instrument could not exist as a profitable commercial item.

MILITARY HYGIENE

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sistance to one type of infection usually bears little or no relationship to any other immunity; i. e., the same individual may differ widely in his resistance to different diseases.

From the military standpoint we are most interested in the acquired immunities, rather than the natural or inborn resistances. When the individual's body builds up its own resistance when stimulated by the introduction of a vaccine, we call it an *actively* acquired immunity. When the immunity is conferred, as in the case of convalescent blood serum from another human being who has recovered from the same disease, or an antitoxin produced in the blood of the horse, we designate it as a *passively acquired* immunity.

A VACCINE may be a solution of dead germs, no longer capable of multiplying (e. g. typhoid vaccine); a culture of germs weakened by chemical treatment, heat, or animal passage (smallpox vaccine); or a small amount of the weakened toxin (poison) produced by a culture of the germs. Such a toxin, weakened by chemical or heat treatment, is called a *toxoid*. This is the type of vaccine used to immunize to tetanus, diphtheria, or scarlet fever.

No vaccination will cause more than the mildest and temporary symptoms of the disease against which it is designed to protect you. But the body will be stimulated to build up in the blood the same kind of immunity that would be produced by recovery from the actual disease.

Most immunities given to military personnel are of the vaccine type. Some actual cases of disease might be treated with a convalescent serum or an antitoxin, in order to lessen the severity of the attack or increase the chances for recovery. These protective blood serums, either human or from the horse, are of value both as a means to prevent specific infections (prophylactic value) and, as noted above, as valuable therapeutic (treatment) aids. The vaccines are almost exclusively used for prohpylactic purposes.

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EDUCATION OF SCIENCE TEACHERS

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or five. It may happen that in reaction to this situation the principal will swing to the other extreme and demand the teacher be trained to teach anything in the curriculum.

AS A REMEDY the colleges must provide a "concentration" in at least three of the following subjects — biological science, chemistry, earth science, physics and mathematics. The complete program should be worked out cooperatively between the science departments and the departments of education. Approximately one-half of a four year course would be devoted to such a schedule, and the student would not enroll for a major in chemistry, physics, or mathematics, but for a science teaching major. Under this plan he could take as much as 24 hours in one subject and 18 hours in each of two others. This leaves ample room for general education requirements and required professional courses in education.

Referring to the emphasis put on areas of study by the National Committee on Science Teaching, areas such as The Human Life Cycle, and Maintenance of Public Health, this comment is made: "These topics would figure in a more important way if teachers knew more about them." That the science teacher should have more experience involving social and historical implications of science is agreed to and emphasized, as is also his need of being better developed as a person. However, the report calls attention to the utmost importance of knowing that it is the quality of the courses in social studies leading to these ends which counts, rather than quantity.

To help in carrying out the proposals in the report the committee recommends certain changes in the certification of teachers by state boards which would make possible, first, a "broad area" plan in training science teachers, and second, a limiting of non-science courses.

SCIENCE IN GRADES

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marked with the earth's volcanic belt and the principal active and extinct craters; the story of some famous eruptions was looked up; a model of a volcano was constructed and used. After a week or so, a program was prepared summarizing the study and this was presented to a neighboring room. This is an instance of stimulating an interest which might otherwise have passed unheeded.

5. The classroom teacher has an opportunity to know the children better, and to inter-relate school and out-of-school experiences.

THIS discussion grew out of a study of the period following the Civil War. The historical reasons for the present position of the Negro were brought out. This led into a discussion of race hatred and the false ideas of race superiority as evidenced by Hitler's Nazism. The teacher presented some of the facts about race as they are accepted by scientists, and used the banning by the House Military Committee of the pamphlet, "The Races of Mankind," as an example of unwillingness to face facts. This led to such an animated discussion that it was continued informally in the yard during recess with practically all the girls of the room. Some of the Jewish girls in the group were able to see the basic patterns of hate and prejudice as it applied to them, especially in their out-of-school experiences.

6. This program also provides a valuable opportunity for inter-grade contacts that would be difficult to achieve with a rigid schedule.

Here is how this happened. One day when we were having a consultant meet with half the teachers at a time, my room entertained a first grade group. At the request of their teacher, we introduced them to magnets and what they will do. The eighth graders did a few simple experiments, and then gave the first graders a chance to manipulate the magnets. This visit served to build up some acquaintances between the two groups, so that the little children felt the older ones were their friends.

A week or so later the first graders raised the question, "What is inside the earth?" When their teacher suggested that they stop guessing and try to find out, they proposed asking the eighth graders. This was done, and at the appointed time three eighth grade boys tried to answer their question. They held their audience spellbound for fifteen minutes. Milton in particular made quite a hit with the little ones—he knew how to talk to them on their own level. As he left, a little girl called out, "Goodbye, lovely Milton, goodbye!" And what was the reaction of the eighth graders? When the boys returned I asked, "Well, how did you get along?" "Oh, fine," said Joe, "You know, they're pretty smart down there!"

Summary

IN THE elementary school, science helps the child to grow in his understandings, to develop a way to tackle problems, to appreciate the value of science in our modern world.

We attempt to achieve these basic purposes by using the teacher with special training, integrating science with other subjects, having a flexible time schedule, utilizing children's experiences and interests, relating school and out-of-school experiences, and providing opportunity for inter-grade contacts.

TEACHING BIOLOGY AND GENERAL SCIENCE

Continued from Page 21

teaching methods used in teaching them in certain colleges and universities instead of in the development of methods adapted to the needs of the student in the secondary schools. Some sort of laboratory work is necessary in connection with both subjects. But what sort? In my own laboratory we are attempting to determine in a quantitative way what teaching methods in the laboratory are best adapted to the needs of the students, that is, what methods give the best and quickest results in terms of learning by students. I regret that these experiments have not yet proceeded far enough to give a final answer to the question. However, we have gone far enough so that I have developed some pretty well-defined opinions in the matter. I am convinced that the easiest method, the one so commonly followed of insisting on splendidly finished drawings, is the most time consuming and the least productive of results in learning. The labelling of drawings furnished to the student seems to get fully as good results with the expenditure of only a fraction of the time. Class demonstrations by students or by the teacher often secure as good results in learning as are obtained by much more laborious and time-consuming individual laboratory work.

Do not misunderstand me. I believe fully in thoroughness. My own method is either to present preliminary work in the classroom, followed by a laboratory treatment of the same subject matter, or else to present the subject first in the laboratory and to clinch the ideas later in the classroom. The latter nearly always consumes much more time. In any case it is my opinion that the laboratory work and the classroom assignment should cover the same ground and should thus supplement each other closely. This brings the student in contact with the same subject matter twice but from different points of view. Then there must be frequent reviews, at least once a

week. This provides a third contact with the subject matter.

Finally the examination. And I want to say that I am not entirely orthodox in the matter of the examination. In consider it a waste of time, time that could be devoted to additional classroom exercises, to give examinations simply for the purpose of getting marks to record. Any teacher who spends a semester or even a quarter with a group of students should be able to grade those students quite as acurately without an examination as with one. In my estimation an examination should serve the purpose of motivating the student to do some thorough reviewing. In fact, I doubt if there is any other legitimate excuse for giving examinations to secondary school students in classes of ordinary size. It follows that examinations should be rather frequent and over natural divisions of the subject matter. It is my experience that most students will not review well if too large a section of material has to be reviewed at once. This is a strong argument against the practice of giving final examinations. They should be entirely unnecessary for purposes of getting marks to record for the students, and most students are so discouraged when they face the work of an entire quarter or semester that they will not review consistently or effectively. So examinations should be given at frequent intervals over natural divisions of subject matter, and for the main purpose of securing an effective review. This constitutes a fourth contact on the part of the student with the subject matter covered by the course.

The teaching methods I have suggested are adapted to securing thorough learning of the basic facts and principles. I do not consider it good practice to confuse the beginning student with a host of unimportant details. One of my own teachers expressed the idea so many years ago in the expression: "Our aim should be a few well-selected facts, well learned."

MEDICAL CARE

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More Organization Needed

IF MEDICINE were built about hospitals and health centers with integrated staffs and facilities organized to combine the functions of practice, education and investigation, there would be places where young physicians could work and grow. There would be opportunity for continuity of development for all physicians; and a chance to recover their birthright in the production of medicine. There would be appropriate positions for persons with different degres and kinds of competence, and machinery for the development of more specialists. This type of organization has proved its value in our teaching hospitals and in such exemplary institutions of healing as the Mayo Clinic.

The practice of modern medicine requires coordinated effort of practitioners, specialists and technical assistants, along with expensive equipment. To have these distributed in private offices means duplication and partial utilization of facilities with consequent loss of economy and efficiency. It entails waste of time for the patient in seeking these facilities. This explains the steady migration of patients from offices to hospitals and clinics for diagnostic and therapeutic procedures.

NOT THE smallest advantage in the centralization of medicine is the stimulating educational effect of close contact in a cooperative effort between physicians with varied knowledge and skills. Modern medicine cannot be practiced in its entirety by any one man; it has become altogether too complex. Specialization is essential, if only along technical lines. But a technical specialist may become a serious danger if he is allowed to practice his specialty in a vacuum.

PLANT NUTRITION

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2. Keeping a large number of containers safely stored.

3 Keeping the plants watered over the weekends and holidays.

THE EXPERIMENT not only proved interesting to the experimenters, but also was

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ANIMAL NUTRITION

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THE MALE rat of the pair which received the complete diet increased in weight from 39.7 grams to 51.4, 78.0, 98.1, 121.7, 150.9, 188.0, 209.0, and on March 17 it weighed 227.8 grams. The female rat of this pair increased in weight from 39.6 grams to 58.5, 89.8, 107.9, 121.8, 133.5, 156.0, 176.3, and on March 17 it weighed 197.5 grams. The female weighed more than the male until February 18, but after that date the male gradually became larger. The female rat gained weight at an average of about twenty grams a week, whereas the male gained about twenty-four grams weekly.

The students who conducted these experiments have learned many interesting and valuable facts about both nutrition and scientific experimentation. They have learned that it is absorbingly interesting to experiment on living animals. In addition, these experiments have vividly portrayed to them the necessity of eating a diet balanced in every respect. They have seen rats suffering from deficiency diseases due to an undersupply of minerals and vitamins in their diets; they have seen that an oversupply of carbohydrates in the diet leads to unhealthful overweight; they have been convinced that an insufficient protein supply causes stunted growth. Among the many benefits gained from these experiments, a complete realization of these facts is paramount.

TABLE SHOWING WEEKLY INCREASE IN WEIGHT OF RATS

(All Weights Are In Grams)

(Term of Experiment: January 19 to March 17, 1944)

	Rat A	Rat B	Rat C	Rat D	Male of Pair	Female of Pair
1/19/44	37.2	47.6	46.0	40.6	39.7	39.6
1/28	40.1	74.5	62.4	49.9	51.4	58.5
2/5	42.7	96.2	80.8	71.4	78.0	89.8
2/11	46.8	110.5	98.5	83.7	98.1	107.9
2/25	66.5	142.4	138.3	87.5	150.9	133.5
2/18	47.8	126.9	116.3	82.1	121.7	121.8
3/3	93.2	155.3	149.0	92.5	188.0	156.0
3/10	112.0	164.9	159.9	93.7	209.0	176.3
3/17	120.2	167.6	171.2	108.6	227.8	197.5

BOOK SHELF

CELESTIAL NAVIGATION: A PROBLEM MANUAL, Walter Hadel, Chief Navigation instructor, United Air Lines. McGraw-Hill Book Company, New York City, 1944. 271 pp. 13x21 cm. Illus. $2.50.

The book presents a collection of practical problems in celestial navigation, including various calculations in simple dead-reckoning navigation, and is designed as a text, or guide, for a course in celestial navigation. It includes problems from the simplest type to the most complicated. Explanations are given for each type. Tables necessary for the solution of all problems in the text.

An interesting feature is that most of the problems take the reader on imaginary, but entirely practical, navigation trips. All known methods of navigation are included.

RADIO: FUNDAMENTAL PRINCIPLES AND PRACTICES, Francis E. Almstead, Lieutenant, U. S. N. R., Bureau of Naval Personnel, Washington, D. C.; Kirke E. Davis, High School, Oceanside, N. Y.; and George K. Stone, State Education Department, Albany. McGraw-Hill Book Company, New York City, 1944. 219 pp. 13x19½ cm. 160 illus. $1.80.

This book is written to aid the student in getting a sound foundation in the fundamentals of radio either as a basis for further training or for practical use. It could be used in high schools offering radio as a second course following physics. The book is not exhaustive in treatment of the subject, but it does give a clear basic understanding. It covers all the usual areas treated in texts in this field.

PRACTICAL RADIO AND ELECTRONICS COURSE, M. N. Beitman, Radio Instructor, Chicago High Schools. Supreme Publications, Chicago, 1943. In three volumes, total of 367 pp. 21x27 cm. illus. $3.95 for set.

This *Practical Radio and Electronics Course* is for home study for the person that does not have the opportunity to study radio in a school. For this purpose, the books are quite well adapted. The principles are explained in a very simple way, using a wealth of illustrations to make the thought clear.

Each page is made up in double column style with the text presentation of theory in one column and the instructor's comments in the adjoining column. Since the instructor cannot be present, this appears to be next best for the learner.

Volume one presents the fundamentals of radio and electronics; volume two: receivers, transmitters and test equipment; and volume three, applied electronics and radio servicing.

MILITARY APPLICATIONS OF MATHEMATICS, Paul P. Hanson, The Manlius School, Manlius, N. Y. McGraw-Hill Book Company, New York City, 1944. 447 pp. 14x22 cm. illus. $2.40.

The book provides military applications of the mathematics learned in the secondary schools. It pre-supposes a knowledge of elementary algebra, plane trinonometry, plane geometry, and logarithms. Students, especially those preparing to enter the armed forces of the United States, will find it helpful. Teachers of mathematics can find in the book much material to enrich their courses and make them more of a practical nature.

The book is designed as a basic text in the high school for those wanting a mathematical background for flight.

REPORT OF RESOLUTIONS COMMITTEE

Continued from Page 13

the Association, an overall coordinating committee on science curriculum and instruction. (The function of this committee shall be to coordinate the work of the separate committees and to establish procedures whereby the work of the separate committees will be expedited and whereby the results of such work may be made widely available to the members of the Association.

4. That the membership of each of the standing committees above be for a period of several years and that membership be staggered in such a manner that continuation of experienced individuals will be insured from year to year. Committee members shall not be eligible for reappointment to the same committee until an interval of one year from the expiration of term.

5. That steps be taken to devise ways whereby the results of the work of the standing committees might be made available at nominal cost to members of the Association. (The Journal of the Association will suffice for certain aspects of this work, but your committee believes that the possibility of multigraphing materials as they become available or of providing yearbooks of a size commensurate with the desirable materials rather than using the yearbooks for proceedings and speeches of the annual meeting should be explored by the Association).

6. That the Association look forward now to an intensive study of the goals, procedures, and effectiveness of science instruction from the grades through colleges and teacher training institutions for the next five years. That, at the end of a five year period the results of this study be made available in a series of comprehensive reports to the teachers and administrators of American schools.

PLANT NUTRITION

Continued from Page 44

used in the biology classrooms in the study of plant nutrition.

In times when gardens are so necessary, it is important to know the nutritional needs of plants as an aid in keeping them healthy.

TEACHING AIDS

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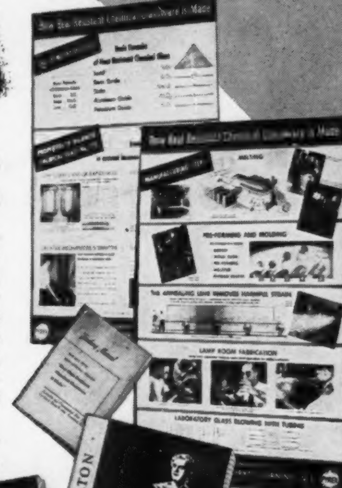

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